Simulate Turning Process using ANN, Predict Optimum Control Factors to achieve Minimum Surface Roughness

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Abstract

Turning is a material removal process, a subtractive form of machining which is used to create parts of circular or rotational form of desired geometry/shape by removing unwanted material. Accuracy of any process depends on involvement of operational variables. The operating parameters that contribute to turning process are Cutting speed, Feed rate, Depth of cut. Vibrations, tool wear, tool life, surface finish and cutting forces etc are also in direct relation with values selected for process parameters. Hence to improve the efficiency of process and quality of the product it is necessary to control the process parameters. Surface roughness is the parameters with main focus, as it dictates the aesthetics and sometimes ergonomical characteristics of the product. The tests were carried out on AISI 4140 steel. 12 speed Jones and Lamson Lathe model was used for turning operation. The specimen with a diameter of 60mm, 500mm length and hardened 35 HRC is used. The tool used for this is one that is most commonly used for turning process DTGNR 163 C 0° Lead Angle 60° Triangle insert. It is product of Kennametal. Statistical Design of Experiments was used to reduce the total number of trials in order to save the time and resources without compromising the accuracy of prediction.

These readings are used to train and validate the Neural Network. ANN is found to be very useful with simulations tasks which have complex and explicit relation between control factors and result of process. Neural Network was created using feed forward back propagation technique for simulation of the process using the Matlab Neural network toolbox. With assurance of accuracy of the predictive capabilities of the neural network, it was then used for optimization. Particle Swarm Optimization Algorithm, an evolutionary computation technique is used find out the optimum values of the input parameters to achieve the minimum surface roughness. The objective function used here is to minimize the surface roughness. Limits of the operational variables are used as constraints for developing the code for optimization algorithm.

Keywords: Turning process, Surface roughness, Artificial Neural Network, Particle swarm optimization.